MFJ VERSA TUNER V

MODEL MFJ-989C

OWNER'S MANUAL

CAUTION: Read All Instructions Before Operating Equipment.

MFJ ENTERPRISES, INC.

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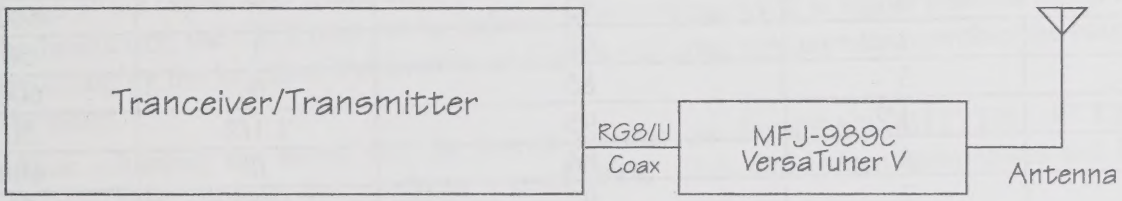
Installation

CAUTION: Locate the tuner so the rear is not accessible during operation.

1. Locate the tuner in a convenient location at the operating position. If random wire or balanced line operation is used, the ceramic feed through insulators may have high RF voltages. These voltages can cause serious RF burns if the terminals are touched when transmitting. **Be sure to locate the tuner so these terminals can not be accidentally contacted during operation.**
2. Install the tuner between the transmitter and the antenna. Use a coaxial cable (such as RG-8/U) to connect the transmitter (or amplifier) to the connector marked **TRANSMITTER** on the rear of the tuner.
3. Connect the antenna(s) to the tuner as follows:
   - **A.** Coaxial feedlines connect to the coax connectors 1 and 2 coax lines (fed directly or through matching circuit as selected by the **ANTENNA SELECTOR** switch.
   - **B.** Random wire or single wire line antennas should be connected to the **WIRE** connector on the back of the unit.

   Note: Route all single and random wire antennas to prevent RF burn hazard.

   - **C.** Any balanced feedline (open wire, twinlead, or twin-axial lines) is connected to the **BALANCED LINE** terminals. Also, connect a jumper wire where indicated.
4. A ground post is provided for an RF ground connection.



Block Diagram
Figure 1

Operation

The roller inductor has *maximum inductance* at about 000 and *minimum inductance* at 125 on the reference counter. The capacitors have *maximum capacitance* at 0 and *minimum capacitance* at 10. In simple language, as the frequency is increased, the normal control positions rotate clockwise just like on other equipment.

Note: Always use the most capacitance (settings closest to 0) for the most power handling and the least loss. Use the smallest possible inductance (the lowest number possible) also.

Note: The MFJ *Air Core*™ Roller Inductor is designed with an exclusive *Self-Resonance Killer*™ that keeps potentially damaging self-resonances away from your operating frequency. This feature is switched in and out of the circuit with a built-in switch in the roller. Therefore, as you turn the roller up and down, you may feel a bump. This is normal and you should not be alarmed.

Increase the number the controls are set at (on a given frequency) to INCREASE the matching range. Remember, this LOWERS the efficiency and power handling capability of the tuner.

1. Tune the exciter into a dummy load (most solid state transmitters are "pre-tuned" to 50 ohms and do not require adjusting with the dummy load).
2. Select the desired antenna with the **ANTENNA SELECTOR**.
3. Position the **ANTENNA** and **TRANSMITTER** controls at the following settings:

160 M:	0	20 M:	4
80 M:	1	17 M:	6
75 M:	2	15 M:	7
40 M:	3	12 M:	8
30 M:	3-1/2	10 M:	8-1/2

   Then place the **POWER** switch in the LO and AVG meter positions.
4. Starting from the minimum **INDUCTOR** position (highest number), turn the **INDUCTOR** control counter-clockwise (adding more inductance) while applying a slight amount of power (less than 25 watts). Tune for the lowest reflected power and maximum forward power (lowest SWR). The lowest reading should occur somewhere above the following recommended inductor positions.

Recommended Tuning Chart

Frequency (MHz)	Transmitter	Inductor (counter indicator)*	Antenna	Load (ohms)
1.8	0	48	0	50
1.8	0	29	0	600
2.0	0	59	0	50
2.0	0	43	0	600
3.5	1	93	1	50
3.5	3	85	0	600
3.75	1 1/2	95	1 1/2	50
3.75	4	86	0	600
4.0	2	97	2	50
4.0	5	87	0	600
7.15	3	110	3	50
7.15	7	106	0	600
10.1	3 1/2	115	3 1/2	50
10.1	8	113	0	600
14.2	4	118	4	50
14.2	8	117	0	600
18.1	6	119	6	50
18.1	8	118	0	600
21.2	7	119	7	50
21.2	8	118	0	600
24.9	8	119	8	50
24.9	8 1/2	119	4	600
28.5	8 1/2	120	8 1/2	50
28.5	9	120	5	600

*Gear drive model.

5. In this order, adjust the **ANTENNA** control, **INDUCTOR**, and **TRANSMITTER** control for lowest reflected power (and SWR). Repeat this step a few times until the reflected power is zero.
6. If the SWR did not reach 1:1 in step 5, turn the **INDUCTOR** control counter clockwise (to a higher number) again and repeat Step 5. For maximum power handling and efficiency, always adjust the capacitors to the lowest front panel number (highest capacitance) that allows proper antenna matching. This insures maximum power handling and lowest power loss in the tuner.
7. Advance the power (do not exceed 100 watts) and, if necessary, touch up the **ANTENNA** and **TRANSMITTER** controls for minimum reflected power and maximum forward power (lowest SWR). Remove the power.
8. After adjusting the tuner for minimum SWR, the amplifier may be turned on. The **METER** switch should be placed in the HI position, and the amplifier tuned according to the manufacturer's instruction.
9. For quick retuning of the tuner, record the **INDUCTOR** and **CAPACITOR** settings for each band.

Note: Maximum power handling occurs when both the **TRANSMITTER** and **ANTENNA** capacitors and the **INDUCTOR** are set at the lowest front panel numbers that permit matching the antenna. Following this guideline will insure maximum power handling capability and efficiency, and the least critical tuning adjustments.

Operating Notes

1. While this tuner is designed to have as large a tuning range as possible, there are limits to the tuning range of the capacitors. Some antennas may require more or less capacitance than the controls have. In these cases, the SWR may not be reduced to 1:1. If the SWR is higher than the limits on your rig, try changing the length of the antenna or feedline to bring the impedance within the tuning range of the tuner.
2. When adjusting the tuner, use the lowest number on the **TRANSMITTER**, **ANTENNA**, and **INDUCTOR** controls that produces a good SWR. This will reduce tuner losses and increase the power rating of the tuner.
3. If the **INDUCTOR** counter slips out of calibration, turn the **INDUCTOR** fully counter clockwise. Then, with a small screw driver or pencil, push the reset button through the hole to the right of the counter. This resets the counter to "000".

WARNING:

1. ***Never*** operate the tuner with the top removed. Contact with the components inside the tuner while transmitting will result in painful RF burns.
2. ***Never*** rotate the **ANTENNA SELECTOR** switch while transmitting. Doing so may permanently damage the switch.
3. Locate the tuner so that the rear terminals ***ARE NOT*** accessible during operation. The single wire and balanced line connections may have high voltage while being used.
4. Disconnect ***all*** antennas from the tuner during lightning storms.
5. Always tune with low power (i.e. less than 100 watts). Apply maximum power only after tuning up.
6. Be sure to adjust the SWR before transmitting at high power (above 100 watts). ***Do Not*** transmit with a high SWR for extended periods of time.

In Case Of Difficulty

If the tuner fails to tune, please **double check** all connections and follow the tuning procedures again. Be sure you are using *enough inductance* (low enough inductance number) and have the *capacitors open far enough* (higher front panel numbers).

If the tuner **arcs** at the rated power levels, please **double check** all connections and follow the tuning procedures again. The power rating of this tuner is 1500 watts PEP RF power. Be sure you are using the *least amount of inductance* (highest number) and the *greatest capacitance* (lowest number) possible that still allows matching the load on the operating frequency.

Note: If this tuner arcs when operating on the 160 meter band, it may be necessary to reduce transmitter output power.

If you are still unsuccessful, but the tuner does adjust and operate when switched to a dummy load or another antenna, please read the **Antenna System Hints** section.

Grounding Hints

To minimize RFI, single wire feedlines (such as used with Windom or longwire antennas) should be kept away from other wiring. Radiation will be minimized if the single wire feeder runs parallel and reasonably close to the wire that connects the tuner to the outdoor ground. The antenna feed wire should be adequately insulated to prevent arcing or accidental contact.

For safety, please use good dc and RF grounds. It is particularly important to have a good RF ground while using a single wire feeder. When using a single wire feeder, the tuner needs something to "push" against in order to force current into the single wire feedline. If a good RF ground is not available, RF will usually find it's way back into the power line (RFI), transmitter audio circuits (RF feedback), or the operator (RF burns).

Water pipes and ground rods provide good dc and ac safety grounds, but they are often inadequate for RF grounding because they are single conductors. Ground rods by themselves are almost useless for dependable RF grounding.

RF grounds work much better when "spread out" over a large area, especially when they employ multiple connections directly to the equipment ground point. Water pipes, heating ducts, and fences may work (especially if they are connected together with multiple wires), but the best RF grounds are radial systems or multi-wire counterpoises. Radials and counterpoises provide large, low resistance surfaces for RF energy.

RF and lightning travels on the surface of conductors. Braided or woven conductors have high surface resistance to lightning and RF. Ground leads for RF and lightning should have wide smooth surfaces. Avoid the use of woven or braided conductors in RF and lightning grounds unless the lead needs to be flexible.

CAUTION: For operator safety, a good outside earth ground or water pipe ground should always be installed and connected to the case of the MFJ-989C. Make certain the safety ground also connects to the transmitter and other station accessories. A wing nut post marked GROUND is provided for ground connection(s).

Antenna System Hints

For operator safety, a good outside earth ground or water pipe ground should always be installed and connected to the case of the MFJ-989C. Make certain the safety ground also connects to the transmitter and other station accessories. A wing nut post marked **GROUND** is provided for ground connection(s).

Location

For the best performance, an end-fed longwire wire antenna should be at least one quarter-wavelength long at the operating frequency. Horizontal dipole antennas should be at least a half-wavelength long and located as high and clear as possible. While good RF grounds help the signal in almost any transmitting installation, it is extremely important to have good RF grounds with long wire or other Marconi style antennas.

Matching Problems

Most matching problems occur when the antenna system presents an extremely high impedance to the tuner. When the antenna impedance is much lower than the feedline impedance, an *odd quarter-wavelength* feedline converts the low antenna impedance to a very high impedance at the tuner. A similar problem occurs if the antenna has an extremely high impedance and the transmission line is a multiple of a half-wavelength. The half-wavelength line *repeats* the very high antenna impedance at the tuner. Incorrect feedline and antenna lengths can make an otherwise perfect antenna system very difficult or impossible to tune.

One example where this problem occurs is on 80 meters when an odd quarter-wave (60 to 70 foot) open wire line is used to feed a half-wave (100 to 140 foot) dipole. The odd quarter-wave line transforms the dipole's low impedance to over three thousand ohms at the tuner. This is because the mismatched feedline is an *odd multiple* of 1/4 wavelength long. The line *inverts* (or teeter-totters) the antenna impedance.

A problem also occurs on 40 meters with this same antenna example. The feedline is now a multiple of a half-wave (60 to 70 foot) and connects to a full-wave high impedance antenna (100 to 140 foot). The half-wave line repeats the high antenna impedance at the tuner. The antenna system looks like several thousand ohms at the tuner on 40 meters.

This places enormous strain on the balun and the insulation in the tuner, since voltages can reach several thousand volts. This can cause component arcing and heating.

The following suggestions will reduce the difficulty in matching an antenna with a tuner:

1. Never center feed a half-wave multi-band antenna with a high impedance feedline that is close to an odd multiple of a quarter-wave long.
2. Never center feed a full-wave antenna with any feedline close to a multiple of a half-wave long.
3. If this tuner will not "tune" a multi-band antenna, add or subtract 1/8 wave of feedline (for the band that won't tune) and try again.
4. Never try to load a G5RV or center fed dipole on a band below the half-wave design frequency. If you want to operate an 80 meter antenna on 160 meters, feed either or both conductors as a longwire against the station ground.

To avoid problems matching or feeding any dipole antenna with high impedance open wire lines, keep the lines around these lengths. [The ***worst possible*** line lengths are shown in brackets]:

160 meters dipole:	35-60, 170-195 or 210-235 feet	[Avoid 130, 260 ft]
80 meters; dipole:	34-40, 90-102 or 160-172 feet	[Avoid 66, 135, 190 ft]
40 meters; dipole:	42-52, 73-83, 112-123 or 145-155 feet	[Avoid 32, 64, 96, 128 ft]

Some slight trimming or adding of feedline may be necessary to accommodate the higher bands.

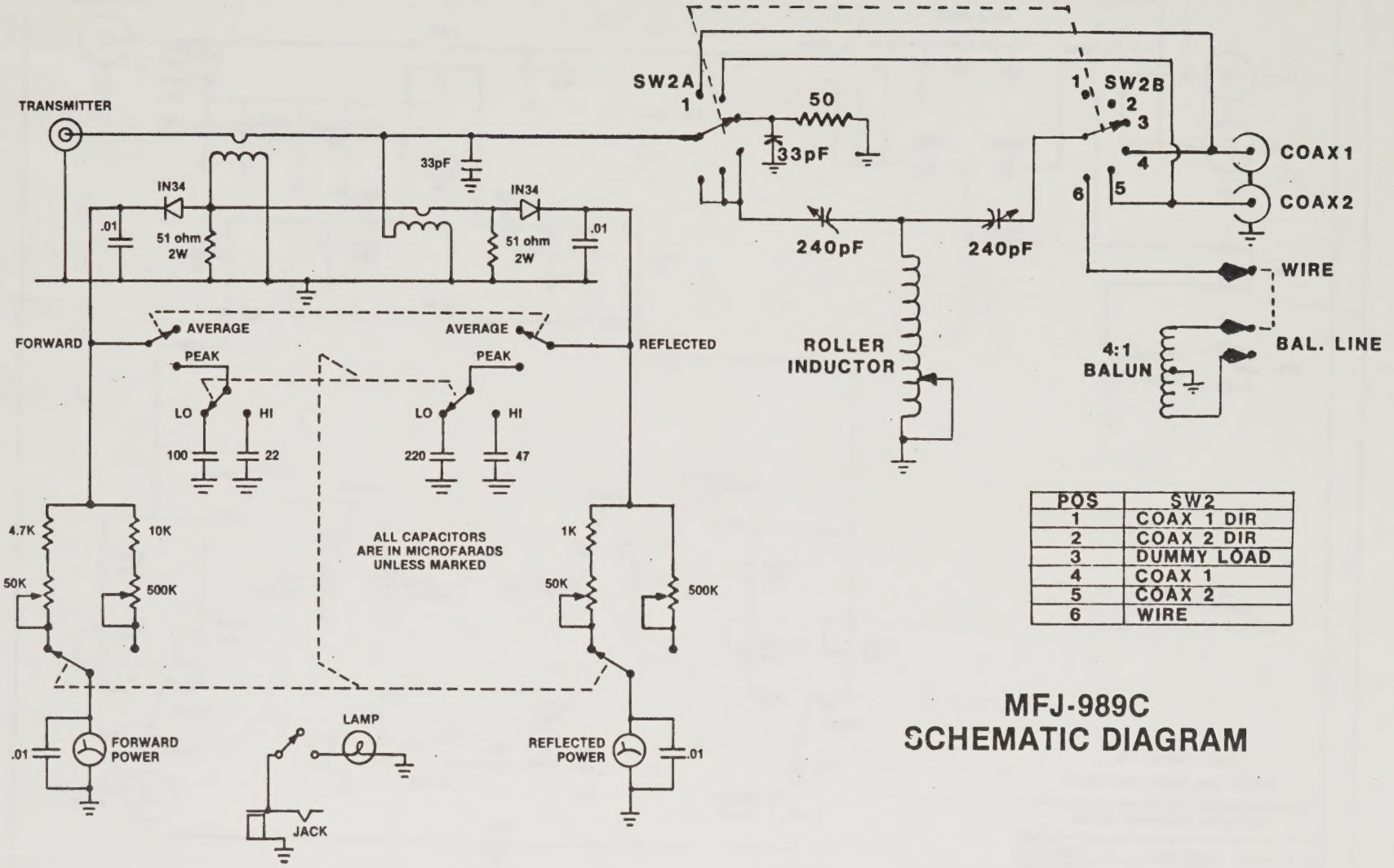
WARNING:

To avoid problems, a dipole antenna should be a full half-wave on the lowest band. On 160 meters, an 80 or 40 meter antenna fed the normal way will be extremely reactive with only a few ohms of feedpoint resistance. Trying to load an 80 meter halfwave dipole (or shorter) antenna on 160 meters can be a disaster for both your signal and the tuner. The best way to operate 160 meters with an 80 or 40 meter antenna is to load either or both feedline wires (in parallel) as a longwire. The antenna will act like a "T" antenna worked against the station ground.

Technical Assistance

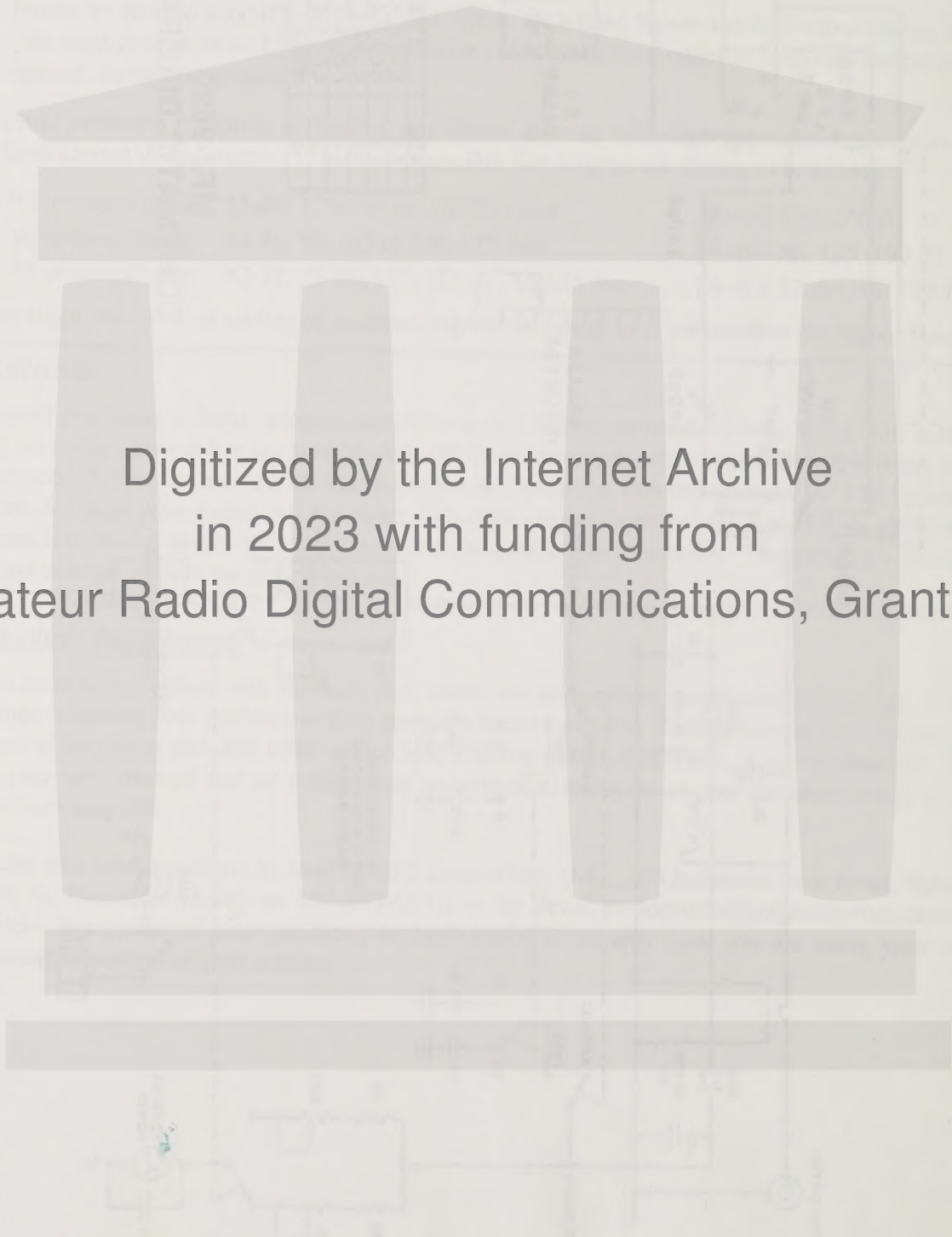
If you have any problem with this unit first check the appropriate section of this manual. If the manual does not reference your problem or your problem is not solved by reading the manual, you may call *MFJ Technical Service* at **601-323-0549** or the *MFJ Factory* at **601-323-5869**. You will be best helped if you have your unit, manual and all information on your station handy so you can answer any questions the technicians may ask.

You can also send questions by mail to MFJ Enterprises, INC., 300 Industrial Park Road, Starkville, MS 39759; by Facsimile (FAX) to 601-323-6551; or by email to techinfo@mfjenterprises.com. Send a complete description of your problem, an explanation of exactly how you are using your unit, and a complete description of your station.



POS	SW2
1	COAX 1 DIR
2	COAX 2 DIR
3	DUMMY LOAD
4	COAX 1
5	COAX 2
6	WIRE

MFJ-989C
SCHEMATIC DIAGRAM



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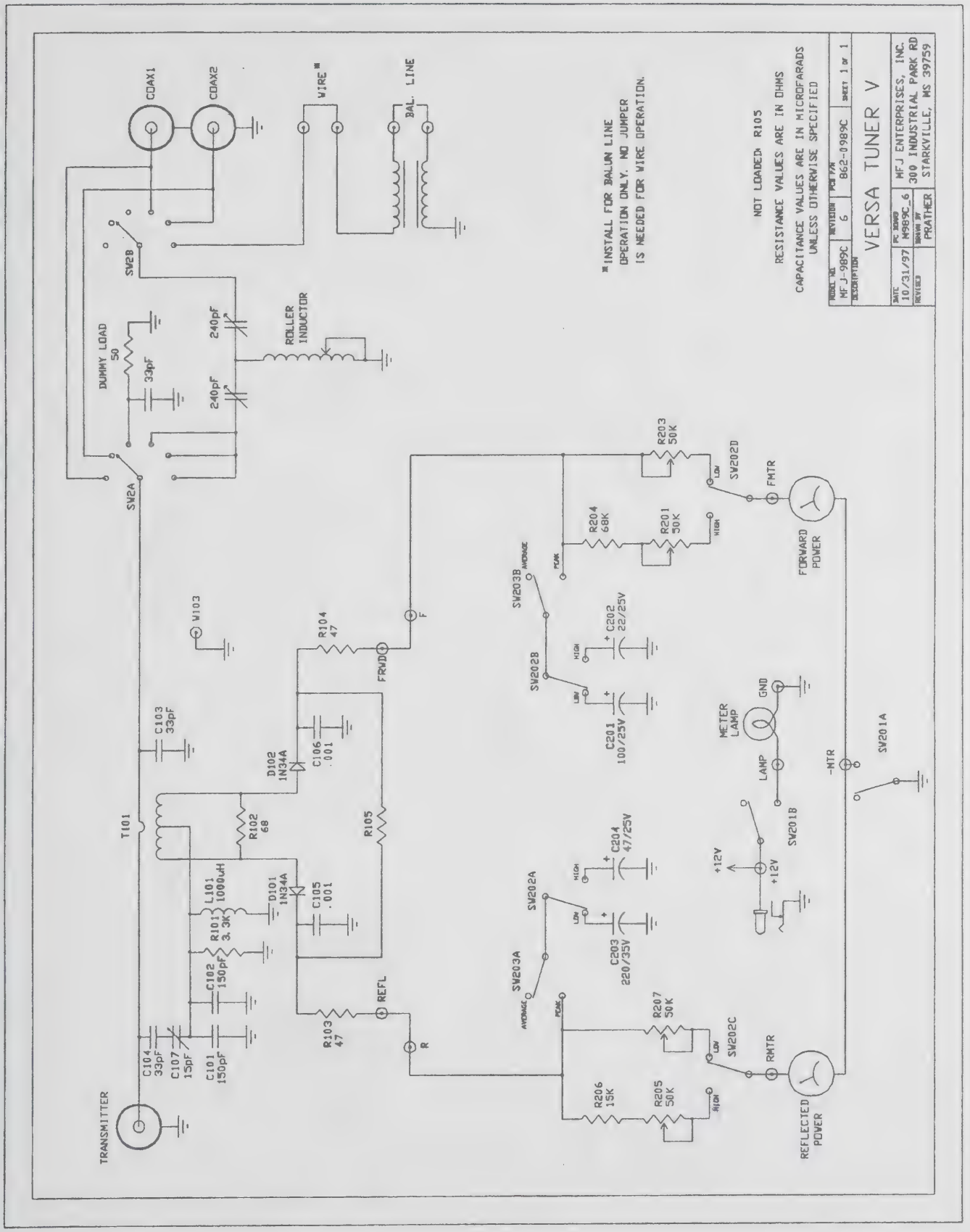
Schematic


VERSA TUNER V
MFJ-989C
6
862-0989C
10/31/97
M989C_6
PRATHER
MFJ ENTERPRISES, INC.
300 INDUSTRIAL PARK RD
STARKVILLE, MS 39759
NOT LOADED: R105
RESISTANCE VALUES ARE IN OHMS
CAPACITANCE VALUES ARE IN MICROFARADS
UNLESS OTHERWISE SPECIFIED
*INSTALL FOR BALUN LINE
OPERATION ONLY. NO JUMPER
IS NEEDED FOR WIRE OPERATION.
COAX1
COAX2
WIRE*
BAL. LINE
DUMMY LOAD
50
33pF
240pF
240pF
ROLLER
INDUCTOR
SW2B
SW2A
TRANSMITTER
T101
C104
33pF
C107
15pF
C101
150pF
C102
150pF
R101
3.3K
L101
1000uH
D101
1N34A
C105
.001
R102
68
C103
33pF
D102
1N34A
C106
.001
R104
47
R105
R103
47
REFL
R
FRWD
F
W103
SW203A
SW203B
AVERAGE
PEAK
SW202A
SW202B
SW202C
SW202D
HIGH
LOW
C203
220/35V
C204
47/25V
C201
100/25V
C202
22/25V
R206
15K
R205
50K
R207
50K
R204
68K
R201
50K
R203
50K
RMTR
FMTR
REFLECTED
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FORWARD
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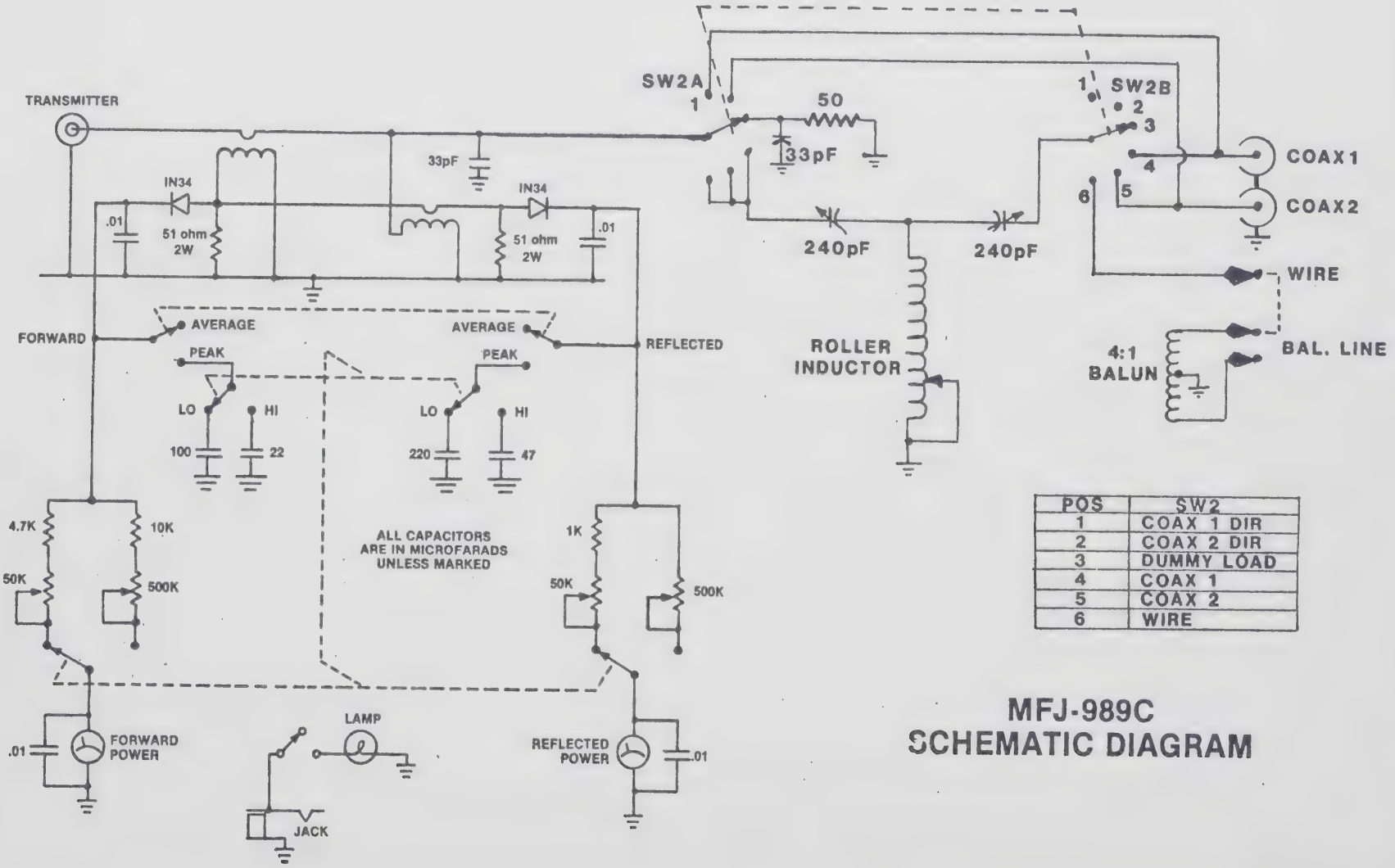
METER
LAMP
LAMP
GND
+12V
SW201B
-MTR
SW201A



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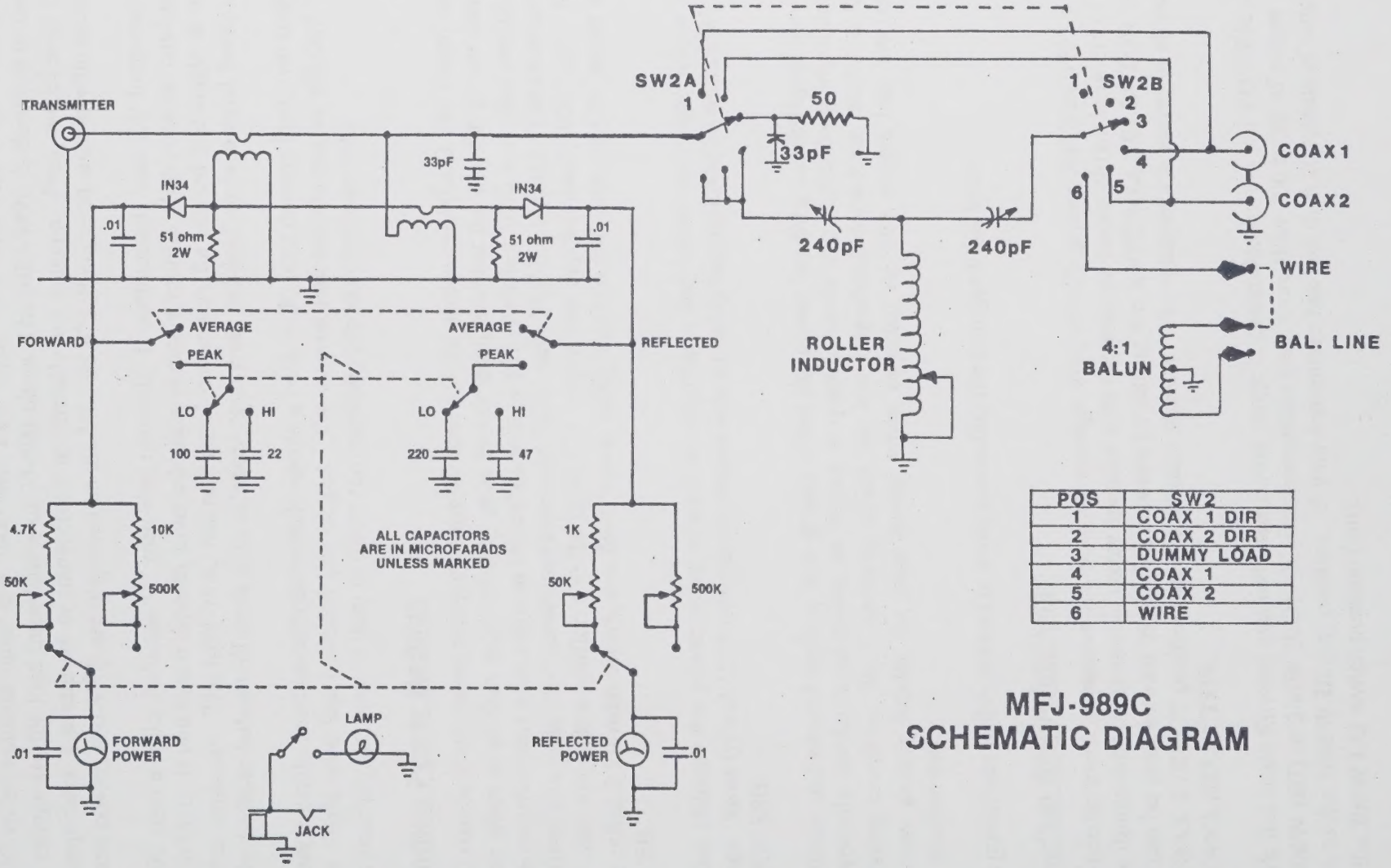

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3	DUMMY LOAD
4	COAX 1
5	COAX 2
6	WIRE

MFJ-989C
SCHEMATIC DIAGRAM

Introduction

The MFJ-989C roller inductor tuner is a 3000 watt **PEP** input, 1500 watt **PEP** output antenna tuner. These power ratings are for load impedances of 35-500 ohms. The MFJ-989C is designed to match 50 ohm output amplifiers, transmitters or transceivers to virtually any antenna. Peak and average forward power, reflected power, and SWR are displayed on the MFJ-989C's illuminated cross-needle meter.

The MFJ-989C uses a roller inductor "T" matching network. It continuously tunes all frequencies from 1.8 through 30 MHz. It will match dipoles, inverted-vee's, verticals, mobile whips, beams, random wires, and many other antennas. The MFJ-989C has rear panel connectors for coaxial and single or two wire feedlines. The **built-in balun** will work with balanced open wire, twinlead, or twin-axial feedlines.

An internal six position antenna-selector switch selects a built-in 50 ohm dummy load, two coaxial line outputs, or a single wire line-balanced line output. The coaxial line outputs can be selected in tuned (with tuner's matching network in line) or direct (no matching circuit) configurations.

Understanding Power Ratings

There are no standardized power rating systems for tuners. The names used (i.e. 3 kW Tuner) carry over from the time when amplifiers were rated by peak power input, and not the true RF power output. For example, the one thousand watt Johnson Matchbox was rated to handle a 1000 watt plate modulated AM transmitter (four kilowatts PEP transmitter input and 3000 watts PEP RF output). The Heathkit SB-220 was called a two kilowatt amplifier, and the rated CW output was approximately 600 watts. Matching tuners were called 2 kilowatt tuners, and these tuners safely handled 600 watts of CW power and 1200 watts PEP SSB.

The FCC has changed the power rating system of amplifiers, and tuners no longer follow amplifier power ratings. Most typical 1500 watt tuners remain able to safely handle 400-600 watts CW, and 600-900 watts PEP SSB.

Load conditions and control settings also greatly affect the power handling capability of the tuner. T-networks typically handle more power on higher frequency bands into higher load impedances. The worst operating condition for T network tuners are low impedance capacitive reactance loads. T-network tuners always handle the least power when operated on 160 meters into low impedance capacitive reactive loads.

Follow the guidelines in this manual to avoid exceeding the ratings of this tuner.

Peak Reading SWR/Wattmeter

The cross-needle meter measures the peak or average FORWARD power, REFLECTED power, and SWR. The illuminated cross-needle meter operates with the antenna tuning circuit in or out of line. The wattmeter can be used without the tuning network by setting the **ANTENNA SELECTOR** to either of the two **COAX DIRECT** positions of the antenna selector. The wattmeter is active in all positions of the **ANTENNA SELECTOR**.

The meter's full scale forward and reflected power range is controlled by the left **POWER** switch that selects **2000W (HI)** or **200W (LO)**. If your transmitter runs more than 200 watts of output power, set this switch to the **2000W HI** (in) position. If your transmitter has less than 200 watts of output, set this switch to the **200W LO** switch position (out).

Peak envelope power (PEP) is measured when the **PEAK** or **AVG POWER** push button (right-hand side) in placed in the **PEAK** (in) position. Peak power and average power values are equal with steady unmodulated carriers, FSK, or FM. The meter reading on these modes will be the same whether the **PEAK / AVG** button is pressed or released. On SSB, the PEP meter reading should be twice the average power with two tone test modulation.

On SSB, the ratio of PEP to average power varies with different voice characteristics. With most voices, the PEP reading is three to five times higher than the average voice power reading. The most accurate peak envelope power readings are obtained only with sustained carrier, voice or two tone test modulation. During normal voice modulation the wattmeter will typically indicate only 70% of the true peak envelope power.

Forward power is displayed on the left-hand FORWARD meter scale. This scale is calibrated from 0 to 200 watts and is read directly in the 200 watt position. Each picket (scale mark) represents 5 watts below 40 watts and 10 watts between 40 and 200 watts. In the **2000W (HI)** position the forward power scale must be multiplied by 10. Each picket represents 50 watts below 400 watts and 100 watts from 400 to 2000 watts.

The reflected power is read on the right-hand REFLECTED meter scale. This scale indicates 50 watts full scale when the **200W** power sensitivity is selected, and 500 watts full scale when the **2000W** power scale is selected. This scale has a picket every watt below 20 watts and every 5 watts above 20 watts. This scale is also multiplied by 10 when using the 2000W power position.

The most accurate power readings occur in the upper half of the meter scales. When trying to measure power with a less than perfect match, the reflected power should be subtracted from the forward power reading.

The SWR is read directly from eleven red SWR curves that range from 1:1 to infinity. SWR is measured by observing the point where the forward and reflected power needles cross. The SWR is indicated by the red curve closest to the needle crossing point. No cumbersome or time consuming SWR sensitivity adjustments are required with this meter.

The wattmeter has an internal lamp that backlights the meter scale. The lamp circuit requires power from an external 12 Vdc source, such as the optional MFJ-1312B power supply. The rear panel jack accepts a 2.1 mm coaxial plug with the center conductor positive (+) and the sleeve negative (-). The negative lead is grounded inside the tuner. The **METER LAMP ON / OFF** switch turns the meter lamp off and on.

Antenna Selector

The **ANTENNA SELECTOR** allows you to select 2 rear panel SO-239 coaxial connectors either direct or through the tuner, a 50 ohm dummy load, and single wire or balanced feedline antennas.